Worksheet: Formula Mass and Moles

Calculate the molar mass of the following:

1. MgO 6. ZnSO4.7H2O

2. CO2 7. Na2CO3.10H2O

3. NaOH 8. fluorine

4. H2SO4 9. sodium phosphate

5. Ba(OH)2 10. iron(III) oxide

List the diatomic molecules:

List the polyatomic molecules:

Fill in the blanks:

1 mole=\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_atoms/molecules=\_\_\_\_\_\_\_\_\_\_\_\_g=\_\_\_\_\_\_\_\_\_\_\_L

Use the mole definition and dimensional analysis to solve the following:

a. grams to atoms

300 gXe=\_\_\_\_\_\_\_\_atoms Xe

b. grams to moles

500 g Cl2=\_\_\_\_\_\_\_\_\_\_moles Cl2

c. moles to atoms

2.6 moles Kr=\_\_\_\_\_\_\_\_\_\_\_atoms Kr

d. moles to grams

5.3 moles F2=\_\_\_\_\_\_\_\_\_\_grams F2

e. atoms to moles

3.01 x 1023 atoms Mg=\_\_\_\_\_\_\_\_\_\_\_moles Mg

f. atoms to grams

1.2 x 1024 atoms Ar=\_\_\_\_\_\_\_\_\_\_\_\_grams Ar

g. molecules to moles

6.02 x 1023 molecules O2=\_\_\_\_\_\_\_\_\_\_ moles O2

h. molecules to grams

1.2 x 1024 molecules Br2=\_\_\_\_\_\_\_\_\_\_\_ grams Br2

Worksheet: Moles

Use the mole definition and dimensional analysis to solve the following:

1. 1 mole Fe=\_\_\_\_\_\_\_\_g Fe

2. 1 mole Ni=\_\_\_\_\_\_\_\_\_ g Ni

3. .42 moles Na=\_\_\_\_\_\_\_\_\_ g Na

4. 134.68 g Pb= \_\_\_\_\_\_\_\_\_\_ moles Pb

5. 90.8 g Ne=\_\_\_\_\_\_\_\_\_\_\_ moles Ne

6. 4.6 moles Ag= \_\_\_\_\_\_\_\_\_\_ g Ag

7. 356 g B=\_\_\_\_\_\_\_\_\_\_\_ moles B

8. Calculate the mass in grams of 5.0 moles of carbon

9. Calculate the mass in grams of 10.5 moles of oxygen

10. Calculate the number of moles in 800 g of calcium

11. Calculate the number of moles in 560 g of bromine

12. Calculate the number of atoms in 3.2 moles of magnesium

13. Calculate the number of moles of atoms in 3.01 x 1023 atoms of zinc

\*\*\*14. Calculate the number of atoms in 0.5 moles of phosphorus.\*\*

15. Calculate the mass in grams of 5.00 moles of ZnO

16. Calculate the mass in grams of 6.00 moles of hydrogen sulfate

17. Calculate the number of moles in 400 grams of sodium hydroxide.

18. Calculate the mass of 192 moles of hydrogen chloride

19. Calculate the number of molecules in 3.0 moles of methane, CH4

20. Calculate the number of grams in 6.02 x 1023 molecules of C12H22O11

\*\*\*21. Calculate the number of sulfur atoms produced when you start with 350 grams of sulfur molecules. \*\*

Worksheet: Empirical Formula

1. Calculate the empirical formula for a compound that is 63.6% nitrogen and 36.4% oxygen.

2. Calculate the empirical formula for a compound that is 92.3% carbon and 7.7% hydrogen.

3. Calculate the empirical formula for a compound that is 57.5% sodium, 40.0% oxygen, and 2.5% hydrogen.

4. A compound is found to contain 39.95% carbon, 6.69% hydrogen, and 53.36% oxygen. Calculate the simplest formula of the compound.

\*\*\*5. Calculate the empirical formula for a compound that is 75.8% arsenic and 24.2% oxygen.

\*\*\*

\*\*\*6. When 1.35 grams of silver oxide are decomposed, there remains a silver residue of 1.26 grams. Calculate the simplest formula of silver oxide.\*\*\*

Worksheet: Molecular Formula

1. Find the molecular formula for a compound with percent composition 85.6% carbon, 14.4% hydrogen, and a molecular mass of 42.1g.

2. What is the molecular formula of cyanuric chloride given the empirical formula is CClN and the molecular mass is 184.5 g.

3. What is the molecular formula for a substance with an empirical formula of TlC2H2O3 and molecular mass of 557 g.

4. Hydrogen peroxide is found by analysis to consist of 5.9% hydrogen and 94.1% oxygen. Its molecular mass is 34.0 g. What is its molecular formula?

\*\*\*5. By analysis, a compound is found to be 76% iodine and the rest is oxygen. Its molecular mass is 334 g. What is its molecular formula? \*\*\*

Worksheet: Percent Composition

THEORETICAL PROBLEMS

1. Determine the percentage of sodium in sodium sulfate, Na2SO4.

2. Calculate the percentage composition of nitrogen in each of the following:

a. HNO2

b. NH4NO3

3. Calculate a) the percent composition of the metal in the following compounds

b) the mass of the metal in each of the following compounds:

a. 50.0 grams MgS

b. 80.0 grams FeCO3

c. 200.0 grams Mg3(PO4)2

EXPERIMENTAL PROBLEMS

4. In a laboratory experiment, barium chloride dihydrate, BaCl2.2H2O, is heated to remove completely its water of hydration. The following data was collected during lab:

empty crucible and cover 20.286 g

crucible, cover and contents before heating 21.673 g

crucible, cover, and contents after heating 21.461 g

Calculate:

a. the experimental percent of water in the hydrate

b. the experimental percent of barium chloride(anhydrous) in the hydrate

c. the theoretical percent of water in the hydrate

d. the percent error of water in the hydrate based on the data obtained in lab.

e. determine the experimental mol:mol ratio between the anhydrous and the water of hydration.

f. Compare to the theoretical mol:mol ratio between the anhydrous and the water of hydration.

5. A compound was experimentally determined to have 12.32 g of hydrogen, 7.82 grams of oxygen, and 10.20 g sodium. What is the percent composition of each element?

THINK PROBLEMS:

\*\*\*6. The mining industry often reports the concentration of metal in an ore in terms of the amount of oxide formed by the metal. Naturally, this figure does not represent the actual amount of metal present. If a rock ore sample is analyzed as containing 1.00% by mass of iron(III) oxide, what is the percent by mass of the iron in the rock? \*\*\*

\*\*\*7. A sample of brass contains by mass 28.0% zinc and 72.0% copper. How many grams of brass can be produced from 6.00 grams of copper? \*\*\*

PRACTICE TEST #1

Worksheet: Everything

1. List all of the diatomic and polyatomic molecules:

2. Determine the molecular(formula) mass of Ca(OH)2

3. Determine the molecular(formula) mass of BaCl2 . 2H2O

4. Determine the number of grams in 2.5 mol NaI

5. Determine the number of atoms in 7.8 mol Zn

6. Determine the empirical formula for 63.64% nitrogen and 36.36% oxygen.

7. Determine the percent composition of the METAL in AgNO3

8. Determine the percent composition for each element in Na2SO4

PRACTICE TEST #2 Worksheet: Everything!!

Molecular mass, moles, % comp, empirical formula

1. List all of the diatomic and polyatomic molecules

2. Find the molecular(formula) mass of sodium oxide

3. Find the molecular(formula) mass of copper(II) sulfate pentahydrate

4. Determine the number of molecules in 70 grams of lithium sulfide

5. Determine the number of ATOMS in 4.2 moles of bromine

6. How many oxygen atoms are in 500 grams of calcium carbonate?

7. Find the empirical formula for 68.4% chromium and 31.6% oxygen

8. Find the percentage of WATER in CuSO4 . 5H2O

PRACTICE TEST #3 Worksheet: Everything!!

Molecular mass, moles, % comp, empirical formula

1. Determine the molecular mass of HNO3

2. Determine the molecular mass of Fe4[Fe(CN)6]3

3. How many moles are in 24.5 g of H2SO4?

4. How many moles are in 95.4 g of Cu?

5. How many grams are in 0.3 moles of oxygen?

6. How many grams are in 3.1 moles of NaOH?

7. Find the percent composition of hydrogen in H3PO4

8. Find the percentage of arsenic in C2H8AsB

9. Find the percentage of copper in CuCO3.Cu(OH)2

10. Calculate the formula of a compound, given that 55.85 g of iron combines with 32.06 g of sulfur.

PRACTICE TEST #4 Worksheet: Everything!!!

Molecular mass, moles, molecular formula, empirical formula, percent composition

1. What is the molecular mass of glycerol, C3H5(OH)3?

2. What is the molecular mass of nickel(II) sulfate hexahydrate, NiSO4.6H2O?

3. How many moles are in 500 g of sucrose, C12H22O11?

4. How many moles are in 1250 g of liquid methanol, CH3OH?

5. How many grams are in 8.78 moles of benzene, C6H6?

6. How many grams are in 3.26 moles of glucose, C6H12O6?

7. Calculate the molecular formula of a compound whose molecular mass is 128 g. Its percentage composition is 93.7% carbon and the rest is hydrogen.

8. Calculate the empirical formula of a compound that is 41.4% strontium, 13.24% nitrogen, and the rest is oxygen.

9. Calculate the percentage of water in the following hydrate: Na2CO3.10H2O

10. In a 10 gram sample of chloromycetin, 4.088 grams is carbon, 0.375 grams is hydrogen, 0.867 grams is nitrogen, 2.476 grams is oxygen, and 2.194 grams is chlorine. Calculate its empirical formula.

Chemistry Lab: Percent Composition of MgO

Purpose: To determine the % composition of Mg and O in MgO

Introduction: Chemists have found that when compounds are formed, elements always combine with one another in definite proportions or quantities by weight. For example, when water is formed, every 1 gram of hydrogen is combined with 8 grams of oxygen. This principle will be proven in lab by forming a compound of magnesium and oxygen and determine the percent composition.

Procedure:

1. Cut a piece of magnesium ribbon 30 cm long. Remove all the magnesium oxide from the piece by rubbing it with steel wool. Wipe clean with a paper towel.

2.Mass a crucible and cover to the nearest 0.01g. Record this mass in your data table.

3. Pinch the magnesium ribbon into a tiny wad and place it in the crucible. Mass the crucible, cover and sample to the nearest 0.01 g. Record this mass in your data table. Do NOT touch the magnesium or the crucible and cover with your hands after this step.

4. Place the crucible on a clay triangle and a ring stand and ring, only touching the crucible with your tongs. Remove the lid with your tongs. Heat the bottom of the crucible with a blue flame for 3 minutes. Now, increase the flame to an inner blue flame. **At the instant the magnesium ignites, put the cover on the crucible.**

5. After a brief period, raise the cover about an inch to admit air and close it again the instant the magnesium begins to burn.

6. Continue the process untill the sample no longer burns(reignites). When this happens, cover about 7/8 of the crucible with the lid and heat the bottom of the crucible strongly for about 5 more minutes.

7. Remove the flame. Place the crucible and cover on a wire gauze pad to cool. It will take about 5 minutes.

8. Mass the crucible and the cover and contents(powder) to the nearest 0.01g .**Only put the crucible and cover on the balance when it is cool** . Record the mass in your data table.

9. Put the contents(powder) on a paper towel. Add water to the powder. Do you detect an odor? What does it smell like? When you are finished, rinse the crucible and cover out with water and return to the bin and dispose of the paper towel in the trash.

Fill in the following chart:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Substance | Ele/Comp | M or NM | S, L or G | Color | Combusts?  Yes or No | Symbol/Formula |
| magnesium |  |  |  |  |  |  |
| oxygen |  |  |  |  |  |  |
| Magnesium  oxide |  | XXX |  |  |  |  |

Data Table: Percent Composition of MgO

1. Mass of empty crucible and cover \_\_\_\_\_\_\_\_\_\_g \*\*

2. Mass of crucible, cover and magnesium sample \_\_\_\_\_\_\_\_\_\_g \*\*

3. Mass of magnesium sample \_\_\_\_\_\_\_\_\_\_g

4. Mass of crucible, cover and MgO \_\_\_\_\_\_\_\_\_\_g \*\*

5. Mass of magnesium oxide, MgO \_\_\_\_\_\_\_\_\_\_g

6. Mass of oxygen that combined \_\_\_\_\_\_\_\_\_\_g

7. Percent oxygen in MgO (experimental) \_\_\_\_\_\_\_\_\_\_%

8. Percent oxygen in MgO (theoretical) \_\_\_\_\_\_\_\_\_\_%

9. Percent error of oxygen in MgO \_\_\_\_\_\_\_\_\_\_%

Calculations:

1.Write a balanced equation that represents the reaction that occurred in lab.

2.Classify this reaction.

3. Calculate the mass of magnesium.

4. Calculate the mass of magnesium oxide.

5. Calculate the mass of oxygen that combined with the magnesium.

6. Calculate the experimental % of oxygen in your sample of magnesium oxide.

7. Write the correct formula for magnesium oxide based on the charges from the periodic table. Now, calculate the theoretical % of oxygen in magnesium oxide using the masses off the periodic table.

8. Calculate a percent error for oxygen in magnesium oxide.

9. List 3 possible lab errors

10. Now using your lab data, change the grams of magnesium and grams of oxygen to calculate the moles of magnesium and moles of oxygen in your sample

11. Using these mole values, find the simplest whole number mole:mole ratio between Mg andO. Use these values to state its experimental empirical formula. Compare this with the theoretical mol:mol ratio which is 1:1. Did you come close to this ratio?

12. If the molecular mass of magnesium oxide is found to be 40.3 g/mol, what is the molecular formula?

Discussion Questions for the “B”:

13. Define the Law of Definite Proportions(aka: Law of Definite Composition)

14. Based on your knowledge of why elements combine, can you explain why the proportions are always the same? Did your lab results prove the Law of Definite Proportions? Explain.

15. List 3 possible lab errors.

For the “A”

16. Research magnesium, oxygen, and magnesium oxide. List properties and uses for each.

There will be an accuracy grade for this lab!!!! I will explain this in class.

Lab: Formula of a Hydrate

Purpose: In this lab, you will determine the amount of water that a given hydrate contains. You will do this by heating the hydrate which will drive the water off. By knowing the mass of the hydrate and the mass of the anhydrous(without water) form, you can determine the number of water molecules(or % water in the hydrate) attached to each molecule of salt. In addition, you will attempt to verify the formula of the hydrate by determining the mol:mol ratio of anhydrous salt to water molecules from your experimental data.

Each lab group will be given one of the following hydrates with the theoretical formula given in parentheses. Your teacher will tell you which ones we are working with this year:

Sodium carbonate decahydrate, Na2CO3 . 10H2O

Magnesium chloride hexahydrate, MgCl2 . 6H2O

Iron(II) sulfate heptahydrate, FeSO4 . 7H2O

Manganese(II) sulfate monohydrate, MnSO4 . H2O

Manganese(II) chloride tetrahydrate, MnCl2 . 4H2O

Copper(II) sulfate pentahydrate, CuSO4 . 5H2O

Magnesium sulfate heptahydrate, MgSO4 . 7H2O

Barium chloride dihydrate, BaCl2 . 2H2O

Cobalt(II) sulfate heptahydrate, CoSO4 . 7H2O

Zinc sulfate heptahydrate, ZnSO4 . 7H2O

Procedure:

a. Obtain a crucible and cover and wash it out with water. You will not be able to get the crucible perfectly clean, but do the best you can. We will assume that anything in the crucible before will also be there after.

b. Make sure the crucible is dry. You may have to heat it a little. Then mass it to the nearest 0.01g. Place this in the data table. After this step, you may only touch the crucible and cover with crucible tongs.

c. You will then receive a hydrate in your crucible about half full(about 5 grams). Again, mass this and place this value in the data table. Don’t forget to include the cover.

d. Place the crucible in a pipestem triangle with the cover slightly ajar and heat with a blue flame for 3 minutes. Then change the flame to an inner blue flame and heat strongly for about 10 to 15 minutes.

e. Turn off the heat and place the crucible and cover on a wire gauze pad to cool. Cool for 5 minutes. Make sure you use crucible tongs and don’t touch the crucible or cover.

f. Mass the crucible, cover and anhydrous(without water) to the nearest 0.01g and place on the data table.

g. When done, **place the anhydrous on a paper towel**. Put a drop of water back onto the anhydrous. Observe what happens. Record results. Then throw out paper towel with the anhydrous and clean the crucible with some water and dry out with a fresh paper towel.

h. Return the crucible and cover to the bin.

i. Put away ring stand, iron ring etc. BUT be very careful because they are still HOT!!!

Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Data Table: Formula of a Hydrate

Substance Letter \_\_\_\_\_\_\_

Experimental Data Table

\*\*a. Mass of crucible and cover \_\_\_\_\_\_\_g

\*\*b. Mass of crucible, cover and hydrate \_\_\_\_\_\_\_g

c. Mass of hydrate \_\_\_\_\_\_\_g

\*\*d. Mass of crucible, cover and anhydrous \_\_\_\_\_\_\_g

e. Mass of anhydrous \_\_\_\_\_\_\_g

f. Experimental % water in hydrate \_\_\_\_\_\_\_%

Calculations: SHOW THE WORK FOR c, e, f

Now, use the periodic table to determine the theoretical % water in **each** of the possible hydrates we used in lab:

g. Mass of water molecules \_\_\_\_\_\_\_g

h. Mass of hydrate \_\_\_\_\_\_\_g

i. Theoretical % water in hydrate \_\_\_\_\_\_\_%

Now, compare your experimental and theoretical percents to determine the identity of your hydrate. Once you have identified the hydrate, do the following:

j. % error of water in hydrate \_\_\_\_\_\_\_%

This will be used to calculate the accuracy grade.

Observations of hydrate before heating:

Observations of anhydrous after heating:

Observations of the anhydrous placed on a paper towel and adding a drop of water after the experiment is done:

Honors classes have additional calculations to determine the experimental mol:mol ratio and compare it to the theoretical mol:mol ratio.

Analysis Questions:

1. What is the purpose in heating the crucible and cover in the beginning of the procedure?

2. Why is it necessary to let the crucible cool before measuring the mass?

3. Why should the mass of the crucible be measured immediately after the crucible cools and not later?

4. What is a hydrate? anhydrous? water of hydration?

5. Does the hydrate look “wet?” Why not.

6. When you heated the hydrate, did you see any water come off? Why not?

7. Why is it important to know the amount of water in a hydrate when you are changing from grams to moles or moles to grams?

Calculations:

8. Determine the mass of the hydrate by subtraction. Determine the mass of the water of hydration by subtraction.

9. Determine the experimental percent composition of the water in the hydrate

10. Determine the theoretical percent composition of the water in the given hydrates to determine which hydrate you were received.

11. Determine the percent error.

Honors perform the additional calculations:

12. Determine the mass of anhydrous by subtraction. Also, determine the mass of water of hydration by subtraction.

13. Change grams into moles for both the anhydrous and water of hydration

14. Divide both by the moles of anhydrous to get the experimental mol:mol ratio.

15. Compare your experimental ratio to the theoretical ratios. They are not exactly the same. Account for this by listing at least 3 possible lab errors.

For the “A”

Research four of the hydrates and give information about each hydrate. This includes properties and uses for each of the hydrates.

There will be an accuracy grade for this lab. It will account for 4 or 5 points out of the total lab grade. It will be determined by how close you get to the actual percent of water in your assigned hydrate. I will use the percent error calculation to determine the number of points you receive. I will explain this in class. There will also be a chemist of the week!!!